(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 124 492 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
24.01.2007 Bulletin 2007/04

(21) Application number: **99952684.1**

(22) Date of filing: **02.11.1999**

(51) Int Cl.:
A61B 17/17 *(2006.01)*

(86) International application number:
PCT/GB1999/003601

(87) International publication number:
WO 2000/025681 (11.05.2000 Gazette 2000/19)

(54) **FRACTURE TREATMENT**

BEHANDLUNG VON KNOCHENFRAKTUREN

TRAITEMENT DES FRACTURES

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(30) Priority: **02.11.1998 GB 9823974**

(43) Date of publication of application:
22.08.2001 Bulletin 2001/34

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(56) References cited:
WO-A-92/01422
BE-A- 678 171
DE-A1- 3 244 243
DE-U- 9 206 580
US-A- 4 522 201
US-A- 5 374 271

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Description

[0001] This invention relates to the treatment of fractures, and it relates especially, though not exclusively, to apparatus for effecting such treatments as are applicable to fractures of long bones such as the humerus.

[0002] A well established and highly successful procedure used in the treatment of long bone fractures involves the use of intramedullary nails which are inserted substantially axially of a bone and to one side of the fracture, and extend through the medullary cavity (reamed out if necessary) and past the region of fracture to an area of sound bone. The proximal end of such a nail is secured to the bone at or adjacent to the region of its entry into the bone, whereas the distal end of the nail has to be secured to the sound bone beyond the fracture. One difficulty associated with this procedure is the accurate location of the nail and its fixing points with which separate securing members, such as transversely inserted fixing devices, e.g. screws, need to engage.

[0003] It has previously been proposed to use radiographic techniques to assist the surgeon in this respect, but it is preferable to avoid subjecting a patient to radiation for such purposes, and accordingly various mechanical procedures have been developed in recent years. Such procedures typically involve the use of jigs which are attachable to the nail during the surgical alignment process and which provide predictive guidance as to the location of the nail (particularly the distal end thereof), thereby to ease the difficulty described above.

[0004] Alignment procedures of this general kind are described in GB 2 288 738 A; GB 2 258 154 A; WO 96/03085 A1; US 5 352 228 and US 4 913 137 and it is an object of this invention to provide improved apparatus and methods for the application, alignment and/or engagement of transverse fixing devices with intramedullary nails, and/or to effect improved stability and/or mobility of fractured bones.

[0005] A device according to the first part of claim 1 is known from DE-A1-3 244 243.

[0006] The invention is defined in claim 1.

[0007] Optionally, the position of the fixture location and the line of insertion of the fixing device is defined by a jig temporarily affixed to the proximal end of the elongate member. Optionally, a guide means is adapted to pass through the fixture location to act as a guide for the desired location of the fixing device. Optionally, a drill means guided by the guide means, is used to form a bore communicating with the fixture location, said bore being adapted to accommodate the fixing device.

[0008] Preferably the guide means comprises a wire, such as a K-wire, and the drill means is axially apertured to accommodate said wire.

[0009] Preferably the elongate member is formed with a plurality of further apertures adjacent the distal end thereof, any or all of which further apertures may be internally threaded.

[0010] Preferably, the elongate member comprises an intramedullary nail configured in the region thereof occupied by said aperture and possibly also said further apertures to permit its close conformity to the inner cortical wall of said bone.

[0011] Preferably also the proximal end of said elongate member also is formed with one or more apertures to accommodate transversely disposed fixing devices.

[0012] Where a plurality of said fixing devices is employed to cooperate with respective apertures adjacent the proximal end of said elongate member, said fixing devices are adapted to pass through the elongate member and into sound bone and are deployed in substantially parallel planes transverse to said elongate member, but are misaligned so as to respectively engage areas of bone more widely separated than the areas that would have been engaged by the fixing devices had they been disposed in alignment with one another.

[0013] In an alternative embodiment, an elongate member is adapted to be passed through a fixing device whereafter the fixing location of the proximal end of said elongate member resides in contact with the fixing device.

[0014] Conveniently, the said fixing device may comprise an aperture whereby said elongate member can pass through the fixing device in use.

[0015] Apparatus according to the invention could be used in a method for the treatment of bone fracture, comprising the steps of:-

inserting the elongate member substantially axially into the bone such that it spans the fracture; the fixture location receiving the fixing device inserted transversely of the elongate member and passing through part at least of the bone to be treated;
defining, by means of a jig temporarily affixed to the proximal end of the elongate member, the position of the fixture location and the line of insertion of the fixing device;
utilising said jig to pass a guide means through the fixture location and along said line of insertion;
anchoring said guide means into sound bone; and
drilling, guided by the guide means, a bore communicating with the fixture location and adapted to accommodate the fixing device.

[0016] Apparatus according to the invention could be used in a method for the treatment of bone fracture, comprising the steps of:

inserting said elongate member substantially axially into the bone such that it spans the fracture; and
utilising the fixing device in cooperation with the fixture location formed in the elongate member to draw the elongate member into intimate contact with said bone.

[0017] A particular application of the invention relates to the treatment of four-part and other fractures of the

surgical neck and shaft of the humerus.

[0018] Comminuted four-part fractures of the upper end of the humerus present particular difficulties in imparting a sufficient degree of stability to the repaired bone structure. In attempting to stabilise the structure, it is necessary to take into account the forces acting on the fracture fragments, such as the supraspinatus muscle and the other muscles of the rotator cuff which act on the main proximal fragment of the fracture through the greater and lesser tuberosities. Sometimes, moreover, the greater tuberosity is a separate fragment and is displaced by muscular pull. The lesser tuberosity may also be a separate fragment, which tends to follow the greater tuberosity fragment because of the close attachment of the rotator cuff muscles.

[0019] Secure fixing of the distal end of an intramedullary nail enables the latter to be used as an internal plate, stabilising the repaired structure.

[0020] In order that the invention may be clearly understood and readily carried into effect, one embodiment thereof will now be described, by way of example only, with reference to the accompanying drawings, of which:

Figure 1 (a) shows a cross section of the proximal end of the patient's humerus from above with an elongate member 2 inserted axially throughout and 1(b) shows a similar view through the distal end of the humerus and elongate member 2. Figures 1(c) and 1(d) show respectively antero-posterior cross sectional and side views of the elongate member 2, with a plurality of holes therethrough;

Figure 2 shows a side view of the patients fractured humerus positioned prior to surgical procedure;

Figure 3 shows a side view of a trocar positioned prior to reaming a channel for an intramedullary nail;

Figure 4 shows a side view of the nail in position in the proximal humerus, with a jig removably attached to the nail;

Figure 5 shows a side view similar to that of Figure 4 and indicates the use of the jig to position the insertion of cannulate trocars into a cancellate region of the humeral head;

Figure 6 shows a side view indicating the line of insertion of so-called K-wires axially of the trocars and into the subchondral bone of the humeral head;

Figure 7 shows a side view similar to that shown in Figures 4 to 6 involving the use of centrally apertured drills inserted (following removal of the trocars) axially over the K-wires, using the latter as guides, to drill the lateral cortex to respectively receive proximal fixing screws;

Figure 8 shows a side view similar to that shown in Figures 4 to 7 and indicates the insertion of screws over the K-wires;

Figure 9 shows a side view similar to that shown in Figure 6 indicating the removal of K-wires from the humeral head;

Figure 10 shows a side view indicating the line of insertion of K-wires axially of the trocars and into the cortical bone of the humeral shaft;

Figure 11 shows a side view where at the distal end of the humeral shaft a cannulated drill is passed over a K-wire;

Figure 12 shows a side view of insertion of a cannulated screw into the central position of the distal end of the nail.

Figure 13 shows a side view of the humeral shaft where the proximal and distal screws have been inserted into the bone and through the intramedullary nail.

Figure 14 shows a side view of the nail in position in the proximal humerus, with a jig removably attached to the nail to aid insertion of two K-wires and to aid insertion of a guide wire through a drill guide into the subchondral bone of the humeral head

Figure 15 shows a side view of the guide demonstrating the positioning of the K-wires;

Figure 16 shows the insertion of a drill bit along the guide wire, guided by the jig which is removably attached to a "short" nail.

Figure 17 shows a "flanged" bolt inserted along the guide wire;

Figure 18 shows insertion of an intramedullary nail through the aperture of the "flanged" bolt;

Figure 19 shows a side view of the humeral shaft where the intramedullary nail has been inserted through the "flanged" bolt and secured at the distal end by screws. A locking grub screw is inserted into the "flanged" bolt and a toothed washer may also be inserted to stabilise Tuberosity fracture fragments.

[0021] Referring now to Figure 1(a), the patient's humerus from above is shown at 1, with the proximal end of an elongate member, in this instance an intramedullary fixing nail, indicated at 2. First and second proximal fixing devices, in this case screws 3 and 4, are provided, as will be described more fully hereinafter. These screws pass, transversely of the nail 2, through respective holes

in the shank thereof, into the sound bone of the humeral head, thereby creating a stable structure fixing the humeral head to the humeral shaft. It is preferable, though not essential, that the screws 3 and 4 are inserted through the nail 2 at different angles, though in substantially parallel planes, in order that they may engage portions of the humeral head that are relatively well separated from one another. This expedient assists in creating a structure stably fixing the humeral head to its shaft, though clearly the profile of the nail itself and the profile and/or dimensions of the respective holes therein through which the screws 3 and 4 pass must be formed so as to accommodate the splayed insertion of the screws.

[0022] Typically in this respect, the proximal portion 5 of the nail 2 is round or ovoid or rectangular in cross-section whereas the remainder of the nail 6 is ovoid or a curved oblong or rectangular, or otherwise conforms to a generally flattened cross-section, to enable it to be used as an internal plate, whereby, as shown in Figure 1(b), the distal end of the nail may be drawn, by means of one or more lateral fixing screws 7, intimately against the internal surface of the humeral shaft 8.

[0023] Figures 1(c) and 1(d) show respectively antero-posterior cross sectional and side views of the nail 2, with a plurality of holes therethrough. Holes 9 and 10 are adjacent the proximal end of the nail and holes 11, 12 and 13 near the distal end thereof; at least the hole 12, but preferably all three being internally screw-threaded in order to permit the use of the nail 2 as a supportive plate, as illustrated in Figure 1(b). The plates may contain any number of holes greater than 3 if necessary.

[0024] With reference now to Figure 2, the humeral head and shaft are shown at 1 and 8 respectively, together with certain adjacent anatomical features such as the acromion process 14, the deltoid muscle 15, the greater tuberosity 16 and the glenoid 17. The surgical neck is indicated at 18 and the bone fracture is indicated at 18'.

[0025] The line of surgical approach is shown by arrow 19, splitting the deltoid muscle 15 to reach the point of insertion of the nail 2

[0026] A trocar 20 is inserted, as shown in Figure 3, close to the point at which the nail 2 is to be inserted, through a small incision just lateral to the acromion 14, so that it passes close to the lateral cortex. If this should prove difficult, for example because the humeral head is in abduction, the insertion of a bone awl or external fixator screw on an introducer into the humeral head (proximal fragment) will allow it to be manipulated into an appropriate position.

[0027] An antero-lateral approach to the shoulder may be used in addition, if the fracture proves difficult to reduce.

[0028] As shown in Figure 4, a jig 21 is removably attached to the top of the nail 2 before introduction, to guide its insertion. The jig 21 is constructed and dimensioned so as to act as a guide for the insertion of transverse locking/location screws such as 3 and 4 at the proximal end and others at the distal end as previously outlined and as to be described in more detail hereinafter. Jig 21 engages a slot in the top of the nail 2 and is removably fixed in position by means of a screw 22 engaging an internal screw thread formed, in known manner, axially in the top end of the nail 2. The cortical bone of the humeral shaft in cross-section is represented at 8'.

[0029] In order to securely affix the proximal end of the nail 2 to the humeral head, the procedure illustrated in Figures 5 to 9 is followed. Using holes in the jig 21 designed to align with the holes 9 and 10 in the nail 2 (Figure 1), for alignment, drill holes are made in the bone which ultimately define the positions of proximal screws in the cancellous bone of the humeral head. Trocars 23 and 24, with tissue protectors shown at 23a and 23b in Figure 7, are first introduced through a small skin puncture. K-wires 25 and 26 are then passed axially down the trocars 23, and 24 and securely anchored into the subchrondal bone of the femoral head. A principal purpose of the wires is to serve as guides for a subsequently performed drilling procedure. The trocars are next removed and a drill which is axially apertured to accommodate a wire, inserted over each of the K-wires in turn (as indicated at 25a and 26a in Figure 7) to drill into the lateral cortex in spaced-apart positions as described with reference to Figure 1(a). Such a drill will hereinafter be referred to as a cannulated drill; the intention being that it is accurately guided by the K-wire passing centrally through it.

[0030] A measuring device is then used to measure the required screw length, and cannulated (axially apertured) cancellous screws 27 and 28 of length chosen to terminate 5mm short of the subchondral bone of the humeral head are then passed over the K-wires, which later are then removed, leaving the screws 27 and 28 in position.

[0031] The screws to engage with the distal end of the nail 2 are inserted similarly, according to the sequence illustrated in Figures 10 to 13.

[0032] As at the proximal end of the nail 2, trocars 29, 30 and 31 with tissue protectors are inserted down to the bone, and respective K-wires 32, 33 and 34 passed therethrough to securely anchor in the opposite (medial) cortex through the respective holes 11, 12 and 13 (Figure 1) in the nail 2. The middle hole of the three 12 is preferably drilled first, using a cannulated drill (indicated at 33a in Figure 11) as before, guided by the K-wire 33 which passes axially through it. A cannulated screw 35, long enough to engage only the threaded hole 12 in the nail, is then inserted and screwed up, drawing the nail into intimate contact with the inner cortex so that it acts as an internal plate and thereby providing increased stability cf the repair. The screw head should be large or preferably of normal size or with a washer large enough to spread the load to prevent the screw breaking out of what may be relatively osteoporatic bone in an elderly person. A second screw may be inserted in the same way to create even firmer contact between the nail 2 and the bone, and the other cannulated self-tapping screws 36, 37 are then

likewise inserted, though these are of length sufficient to ensure gripping both of the respective screw threads formed in the holes 11 and 13 through the nail and of the medial cortex.

[0033] The jig 21 has then served its purpose and is removed; the axial screw-thread at the proximal end of the nail 2 thus vacated receiving instead a screw-in top 38 (Figure 13) that holds a washer 39 which may be apertured (39a) and/or formed with radially extending claws (39b). The rotator cuff muscles may be stitched to the washer and/or attached to the nail via the aforesaid claws to transmit force through the nail 2 to the humeral shaft, creating a stable structure. Other fracture fragments may be attached by means of interfragmentary screws or circlage wires.

[0034] In an alternative embodiment as shown in Figures 14-19, the insertion of two locking/location screws such as 3 and 4 may be substituted by the insertion of one "flanged" bolt 47 (Figures 17 to 19).

[0035] The steps previously demonstrated in Figures 5 to 9, may be substituted with the following. An intramedullary nail 2 is inserted into the humeral head whilst removably attached to a jig 21. A drill guide 41 is then used to aid the placement of a guide wire 42 through the humeral head 1 whereby the guide wire is passed axially down the drill guide and is securely anchored into the subchrondal bone of the humeral head (See Figure 14). The jig allows accurate positioning of the guide wire. The preliminary intramedullary nail 2 is slotted into the coronal plane in such a manner as to permit its removal without displacing the affixed guide wire 42. The jig 21 contains a telescopic section to permit insertion and withdrawal of the nail 2.

[0036] The jig 21 also aids accurate positioning of the two K-wires 43 and 44 (See Figure 15). The function of the K-wires is to maintain the fracture position until a final nail 2' (See Figure 18), which is to remain implanted in the bone (in the coronal plane) throughout treatment, is inserted into the bone.

[0037] Prior to insertion of the final nail 2', the preliminary intramedullary nail 2 is replaced by a "short" intermediate nail 46 as shown in Figure 16. The "short" nail is inserted into the tuberosity in the coronal plane to provide additional stability to the K-wires whilst the humeral head is prepared for the "flanged" bolt 47.

[0038] A cannulated drill bit 45 is placed over the free end of the guide wire 42 (See Figure 16) and is moved along the wire to drill into the bone. Once drilling is completed the drill bit 45 is removed and a cannulated "flanged" bolt 47 is inserted into the drilled hole along the guide wire 42 (See Figure 17)running throughout the cannulated bolt. The "short" preliminary nail 46 is still in place and continues to provide stability while the "flanged" bolt is being inserted. The "flanged" bolt 47 comprises an insertion section 60 and an extension section 61. The extension section 61 is removably attached to the insertion section by way of a threaded locking pin 62.

[0039] Once the "flanged" bolt has been inserted, the "short" intermediate nail 46 is removed and the final intramedullary nail 2' inserted through an aperture 40 provided in the "flanged" bolt 47. The guide wire 42 and K-wires 43 and 44 can then be removed (See Figure 18).

[0040] When the final intramedullary nail 2' has been safely located in position through the bolt 47, the bolt extension 61 and jig 21 can be removed. The final nail 2' and bolt 47 are locked together by insertion of a grub screw 49 which thereby stabilizes the structure, locking the final nail 2' (See Figure 19). A toothed washer 50 may be inserted to enhance stability of tuberosity fracture fragments. Screws such as 35, 36 and 37 are inserted as before (See Figures 10 to 13) in the distal portion of the final nail 2' to secure the implant to the distal fracture fragments.

[0041] It will be appreciated by those skilled in the art that relatively longer nails can be used to provide fixation of fractures of the shaft of the bone. It will also be appreciated that such a nail can be adapted for use in any bone throughout the body.

Claims

1. Apparatus for the treatment of a fracture in a bone, the apparatus comprising:

a fixing device (35) ; and
an elongate member (2, 2') capable of substantially axial insertion into the bone to span the fracture, the elongate member (2, 2') having adjacent one or both of its proximal and distal ends thereof a fixture location means (12) for engagement with the fixing device (35) inserted through the bone transversely of the elongate member (2, 2');

said fixture location means (12) comprising a threaded aperture and said fixing device (35) comprising a screw having a corresponding threaded portion; said fixture location means (12) and a distal end of said fixing device (35) are formed to secure together **characterised in that** said screw (35) has a length limited to engagement with said fixture location means (12) such that during securing said fixture location means (12) and the proximal end of said fixing device (35) are drawn together with the proximal end of said fixing device (35) contacting the outer surface of the bone and said elongate member (2, 2') being drawn against the inner surface of the bone.

2. Apparatus according to claim 1 comprising at least one further aperture (11, 13) provided in the distal end of said elongate member (2, 2') and at least one respective screw (36, 37) adapted to be received in the at least one further aperture.

3. Apparatus according to claim 2 wherein the at least one further aperture (11, 13) comprises a threaded aperture.

4. Apparatus according to claim 2 or claim 3, wherein the fixing device (35) is shorter in length than the at least one respective screw (36, 37).

5. Apparatus according to any preceding claim, wherein the elongate member (2, 2') is in the form of an intramedullary nail having the region of the distal end configured to permit close conformity to the inner surface of the bone.

6. Apparatus according to any preceding claim, further comprising one or more additional fixing devices (3, 4, 27, 28); wherein the proximal end of said elongate member (2) is formed with one or more apertures (9, 10) to accommodate transversely disposed respective additional fixing devices (3, 4, 27, 28).

7. Apparatus according to claim 6, wherein a plurality of apertures are formed in the proximal end of the elongate member (2) with an orientation whereby respective transversely disposed additional fixing devices (3, 4) are accommodated by passing through the respective apertures into sound bone in substantially parallel planes transverse to said elongate member (2), but axially misaligned so as to respectively engage areas of bone more widely separated than the areas that would have been engaged by the additional fixing devices (3, 4) had the apertures been oriented in axial alignment with one another.

8. Apparatus according to any one of claims 1 to 5, further comprising an additional fixing device (47) having an aperture therein; and wherein the elongate member (2') is formed for insertion through the additional fixing device aperture whereby the proximal end of said elongate member (2') is fixed by contact with the additional fixing device (47).

9. Apparatus as claimed in any preceding claim, also including a jig temporarily affixable to the proximal end of the elongate member (2, 2') to define the line of insertion of the fixing device (35) relative to the fixture location means (12).

10. Apparatus as claimed in any preceding claim, also including a guide means (33) adapted to pass through the fixture location means (12) to act as a guide for the desired location of the fixing device (35).

11. Apparatus as claimed in claim 10, also including a drill means (33a) which is guidable by the guide means (33) and utilizable to form a bore communicating with the fixture location means (12), the bore being adapted to accommodate the fixing device (35).

12. Apparatus according to claim 10 or claim 11, wherein the guide means (33) comprises a guide wire and the fixing device (35) has an axial aperture to accommodate the guide wire (33).

13. Apparatus according to claim 12 when dependent on claim 11, wherein the drill means (33a) has an axial aperture to accommodate the guide wire (33).

14. Apparatus according to any preceding claim, wherein the fixture location means (12) is provided adjacent at least the distal end of the elongate member (2, 2').

Patentansprüche

1. Gerät zur Behandlung einer Fraktur in einem Knochen, wobei das Gerät Folgendes beinhaltet:

   eine Fixiervorrichtung (35); und
   ein längliches Element (2, 2'), dass zur im Wesentlichen axialen Einführung in den Knochen fähig ist, um die Fraktur zu überspannen, wobei das längliche Element (2, 2') anliegend auf seinem proximalen und/oder seinem distalen Ende ein Befestigungslokalisierungsmittel (12) zum Eingriff in die Fixiervorrichtung (35) aufweist, die quer zu dem länglichen Element (2, 2') durch den Knochen eingeführt wird;

   wobei das Befestigungslokalisierungsmittel (12) eine Gewindeöffnung beinhaltet und die Fixiervorrichtung (35) eine Schraube beinhaltet, die einen entsprechenden Gewindeabschnitt aufweist;
   das Befestigungslokalisierungsmittel (12) und ein distales Ende der Fixiervorrichtung (35) gebildet sind, um aneinander gesichert zu werden, **dadurch gekennzeichnet, dass** die Schraube (35) eine auf den Eingriff in das Befestigungslokalisierungsmittel (12) begrenzte Länge aufweist, so dass während des Sicherns das Befestigungslokalisierungsmittel (12) und das proximale Ende der Fixiervorrichtung (35) zusammengezogen werden, wobei das proximale Ende der Fixiervorrichtung (35) die äußere Oberfläche des Knochens berührt und das längliche Element (2, 2') gegen die innere Oberfläche des Knochens gezogen wird.

2. Gerät gemäß Anspruch 1, das mindestens eine weitere Öffnung (11, 13), die in dem distalen Ende des länglichen Elements (2, 2') bereitgestellt ist, und mindestens eine jeweilige Schraube (36, 37), die angepasst ist, um in der mindestens einen weiteren Öffnung empfangen zu werden, beinhaltet.

3. Gerät gemäß Anspruch 2, wobei die mindestens eine weitere Öffnung (11, 13) eine Gewindeöffnung beinhaltet.

4. Gerät gemäß Anspruch 2 oder Anspruch 3, wobei die Fixiervorrichtung (35) eine kürzere Länge als die mindestens eine jeweilige Schraube (36, 37) aufweist.

5. Gerät gemäß einem der vorhergehenden Ansprüche, wobei das längliche Element (2, 2') in der Form eines intramedullären Nagels vorliegt, dessen Region des distalen Endes konfiguriert ist, um enge Konformität zu der inneren Oberfläche des Knochens zu ermöglichen.

6. Gerät gemäß einem der vorhergehenden Ansprüche, das ferner eine oder mehrere zusätzliche Fixiervorrichtungen (3, 4, 27, 28) beinhaltet; wobei das proximale Ende des länglichen Elements (2) mit einer oder mehreren Öffnungen (9, 10) gebildet ist, um quer angeordnete, jeweilige, zusätzliche Fixiervorrichtungen (3, 4, 27, 28) unterzubringen.

7. Gerät gemäß Anspruch 6, wobei eine Vielzahl von Öffnungen in dem proximalen Ende des länglichen Elements (2) mit einer Orientierung gebildet ist, bei der jeweilige, quer angeordnete, zusätzliche Fixiervorrichtungen (3, 4) durch das Durchgehen durch die jeweiligen Öffnungen in den gesunden Knochen in im Wesentlichen parallelen, zu dem länglichen Element (2) quer liegenden Ebenen untergebracht werden, aber axial versetzt, um jeweils in Knochenbereiche einzugreifen, die weiter voneinander getrennt sind als die Bereiche, in die die zusätzlichen Fixiervorrichtungen (3, 4) eingegriffen hätten, wenn die Öffnungen in axialer Ausrichtung zueinander orientiert gewesen wären.

8. Gerät gemäß einem der Ansprüche 1 bis 5, das ferner eine zusätzliche Fixiervorrichtung (47), die eine Öffnung darin aufweist, beinhaltet; und wobei das längliche Element (2') zur Einführung durch die zusätzliche Fixiervorrichtungsöffnung gebildet ist, wobei das proximale Ende des länglichen Elements (2') durch Kontakt mit der zusätzlichen Fixiervorrichtung (47) fixiert ist.

9. Gerät gemäß einem der vorhergehenden Ansprüche, das ebenfalls eine Spannvorrichtung beinhaltet, die vorübergehend an dem proximalen Ende des länglichen Elements (2, 2') anbringbar ist, um die Einführungslinie der Fixiervorrichtung (35) relativ zu dem Befestigungslokalisierungsmittel (12) zu definieren.

10. Gerät gemäß einem der vorhergehenden Ansprüche, das ebenfalls ein Führungsmittel (33) umfasst, das angepasst ist, um durch das Befestigungslokalisierungsmittel (12) durchzugehen, um als eine Führung für die gewünschte Lokalisierung der Fixiervorrichtung (35) zu fungieren.

11. Gerät gemäß Anspruch 10, das ebenfalls ein Bohrmittel (33a) umfasst, das von dem Führungsmittel (33) geführt werden kann und benutzt werden kann, um eine Bohrung zu bilden, die mit dem Befestigungslokalisierungsmittel (12) in Verbindung steht, wobei die Bohrung angepasst ist, um die Fixiervorrichtung (35) unterzubringen.

12. Gerät gemäß Anspruch 10 oder Anspruch 11, wobei das Führungsmittel (33) einen Führungsdraht beinhaltet und die Fixiervorrichtung (35) eine axiale Öffnung aufweist, um den Führungsdraht (33) unterzubringen.

13. Gerät gemäß Anspruch 12, wenn abhängig von Anspruch 11, wobei das Bohrmittel (33a) eine axiale Öffnung aufweist, um den Führungsdraht (33) unterzubringen.

14. Gerät gemäß einem der vorhergehenden Ansprüche, wobei das Befestigungslokalisierungsmittel (12) anliegend an mindestens das distale Ende des länglichen Elements (2, 2') bereitgestellt ist.

Revendications

1. Appareil destiné au traitement d'une fracture dans un os, l'appareil comportant :

   un dispositif de fixation (35) ; et
   un élément allongé (2, 2') capable de s'insérer de façon substantiellement axiale jusque dans l'os pour couvrir la fracture, l'élément allongé (2, 2') présentant, de façon adjacente à l'une des extrémités parmi les extrémités proximale et distale de celui-ci ou aux deux, un moyen de positionnement de montage (12) destiné à se mettre en prise avec le dispositif de fixation (35) inséré dans l'os de façon transversale par rapport à l'élément allongé (2, 2') ;

   ledit moyen de positionnement de montage (12) comportant une ouverture filetée et ledit dispositif de fixation (35) comportant une vis présentant une portion filetée correspondante ;
   ledit moyen de positionnement de montage (12) et une extrémité distale dudit dispositif de fixation (35) sont formés pour s'assujettir ensemble **caractérisé en ce que** ladite vis (35) a une longueur limitée de mise en prise avec ledit moyen de positionnement de montage (12) de telle sorte que durant l'assujettissement, ledit moyen de positionnement de mon-

tage (12) et l'extrémité proximale dudit dispositif de fixation (35) soient amenés ensemble, l'extrémité proximale dudit dispositif de fixation (35) étant en contact avec la surface externe de l'os et ledit élément allongé (2, 2') étant amené contre la surface interne de l'os.

2. Appareil selon la revendication 1 comportant au moins une ouverture supplémentaire (11, 13) fournie dans l'extrémité distale dudit élément allongé (2, 2') et au moins une vis respective (36, 37) adaptée pour être reçue dans cette au moins une ouverture supplémentaire.

3. Appareil selon la revendication 2 dans lequel cette au moins une ouverture supplémentaire (11, 13) comporte une ouverture filetée.

4. Appareil selon la revendication 2 ou la revendication 3 dans lequel le dispositif de fixation (35) est plus court en longueur que cette au moins une vis respective (36, 37).

5. Appareil selon n'importe quelle revendication précédente, dans lequel l'élément allongé (2, 2') est sous la forme d'un clou intramédullaire dont la région de l'extrémité distale est configurée pour permettre une conformité étroite avec la surface interne de l'os.

6. Appareil selon n'importe quelle revendication précédente, comportant en outre un ou plusieurs dispositifs de fixation additionnels (3, 4, 27, 28) ; dans lequel l'extrémité proximale dudit élément allongé (2) est formée d'une ou de plusieurs ouvertures (9, 10) pour accueillir des dispositifs de fixation additionnels respectifs disposés de façon transversale (3, 4, 27, 28).

7. Appareil selon la revendication 6, dans lequel une pluralité d'ouvertures sont formées dans l'extrémité proximale de l'élément allongé (2) avec une orientation grâce à laquelle les dispositifs de fixation additionnels respectifs disposés transversalement (3, 4) sont accueillis en passant au travers des ouvertures respectives jusque dans de l'os sain dans des plans substantiellement parallèles de façon transversale par rapport audit élément allongé (2), mais sont désalignés axialement de façon à se mettre respectivement en prise avec les zones d'os plus largement séparées que les zones qui auraient été mises en prise par les dispositifs de fixation additionnels (3, 4) dans le cas où les ouvertures auraient été orientées en alignement axial l'une sur l'autre.

8. Appareil selon n'importe laquelle des revendications 1 à 5, comportant en outre un dispositif de fixation additionnel (47) dans lequel se trouve une ouverture ; et dans lequel l'élément allongé (2') est formé pour être inséré au travers de l'ouverture du dispositif de fixation additionnel grâce à quoi l'extrémité proximale dudit élément allongé (2') est fixée par contact avec le dispositif de fixation additionnel (47).

9. Appareil tel que revendiqué dans n'importe quelle revendication précédente, comprenant également un gabarit pouvant être temporairement attaché à l'extrémité proximale de l'élément allongé (2, 2') pour définir la ligne d'insertion du dispositif de fixation (35) relativement au moyen de positionnement de montage (12).

10. Appareil tel que revendiqué dans n'importe quelle revendication précédente, comprenant en outre un moyen de guidage (33) adapté pour passer au travers du moyen de positionnement de montage (12) pour faire office de guide pour la position souhaitée du dispositif de fixation (35).

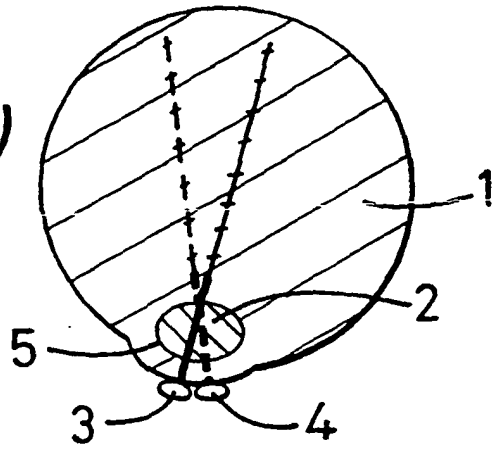
11. Appareil tel que revendiqué dans la revendication 10, comprenant de plus un moyen formant foret (33a) qui peut être guidé par le moyen de guidage (33) et qui peut être utilisé pour former un alésage communiquant avec le moyen de positionnement de montage (12), l'alésage étant adapté pour accueillir le dispositif de fixation (35).

12. Appareil selon la revendication 10 ou la revendication 11, dans lequel le moyen de guidage (33) comporte un fil guide et le dispositif de fixation (35) a une ouverture axiale pour accueillir le fil guide (33).

13. Appareil selon la revendication 12 lorsqu'elle dépend de la revendication 11, dans lequel le moyen formant foret (33a) a une ouverture axiale pour accueillir le fil guide (33).

14. Appareil selon n'importe quelle revendication précédente, dans lequel le moyen de positionnement de montage (12) est fourni de façon adjacente à au moins l'extrémité distale de l'élément allongé (2, 2').

FIG. 1(a)



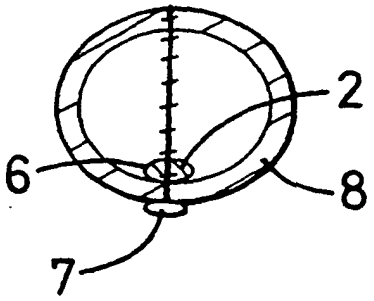


FIG. 1(b)

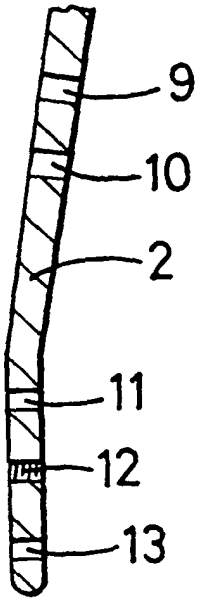


FIG. 1(c)

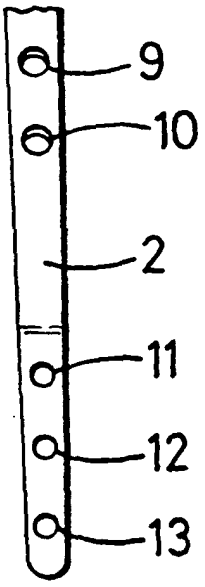


FIG. 1(d)

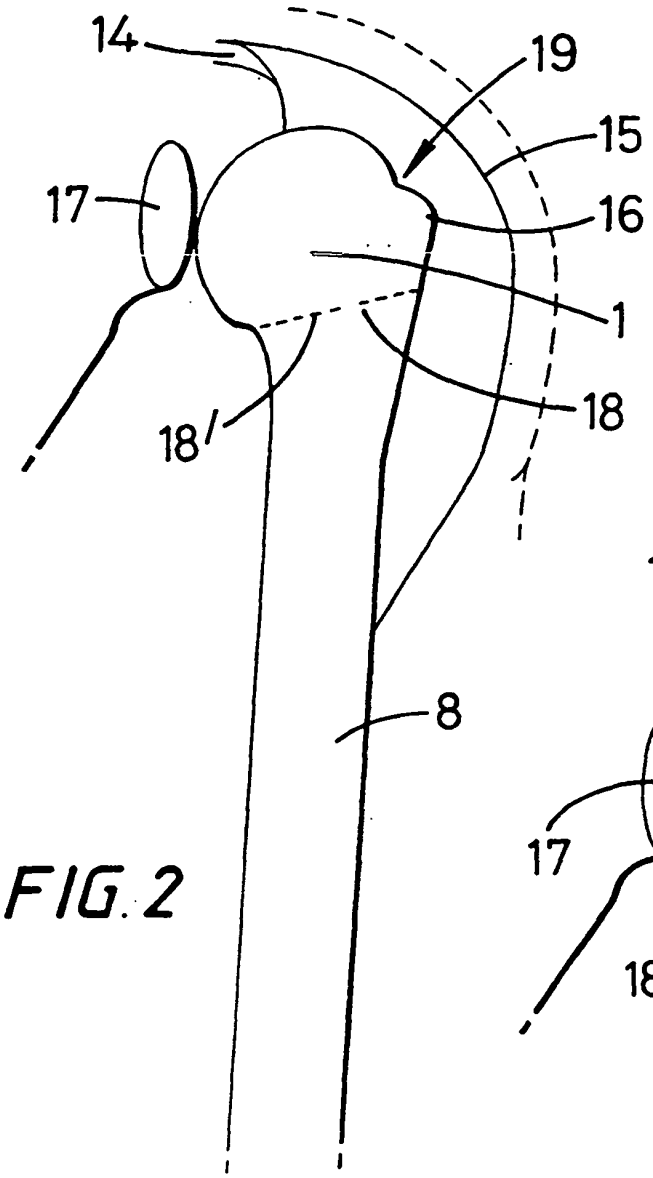


FIG. 2

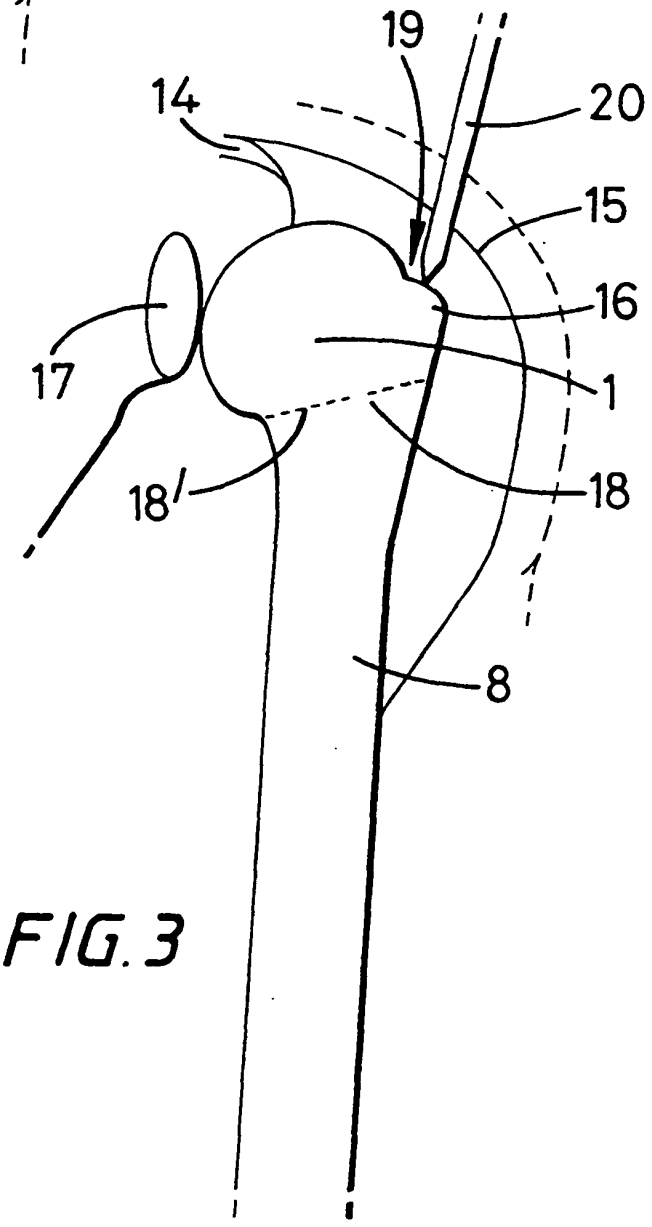


FIG. 3

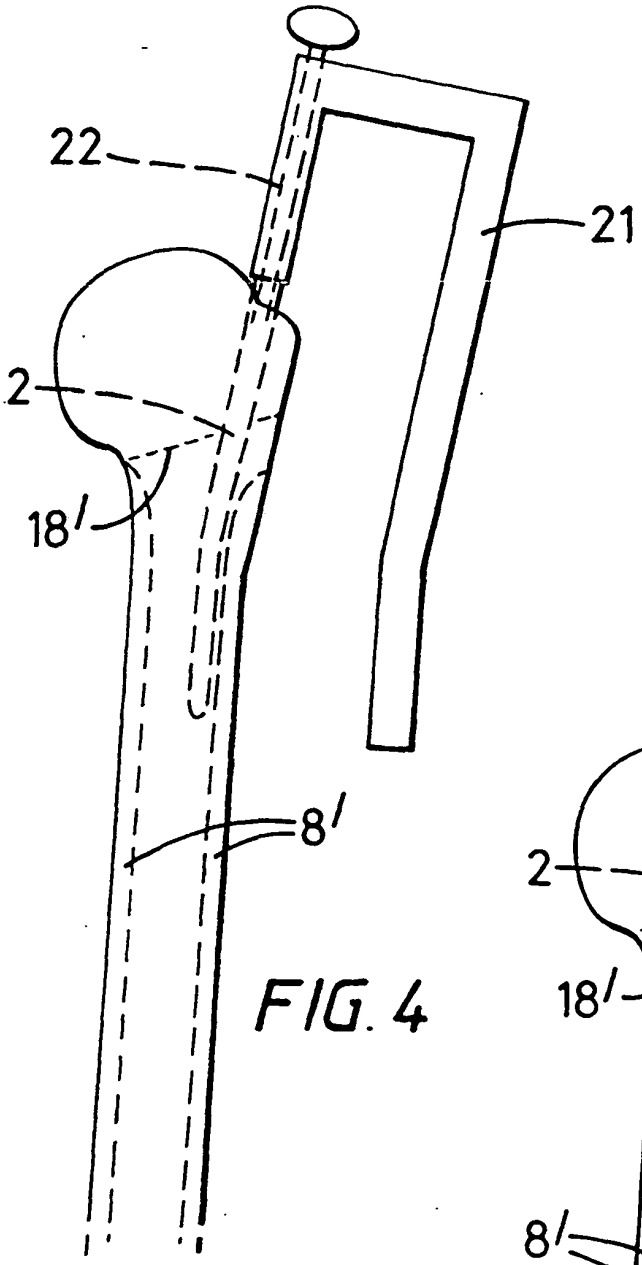


FIG. 4

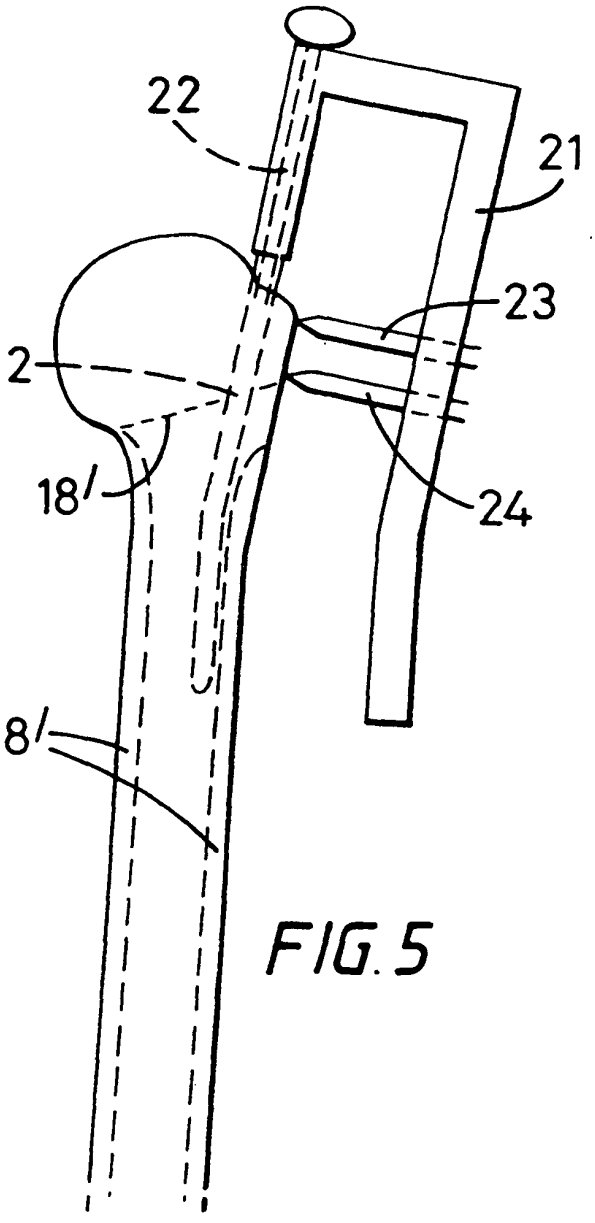


FIG. 5

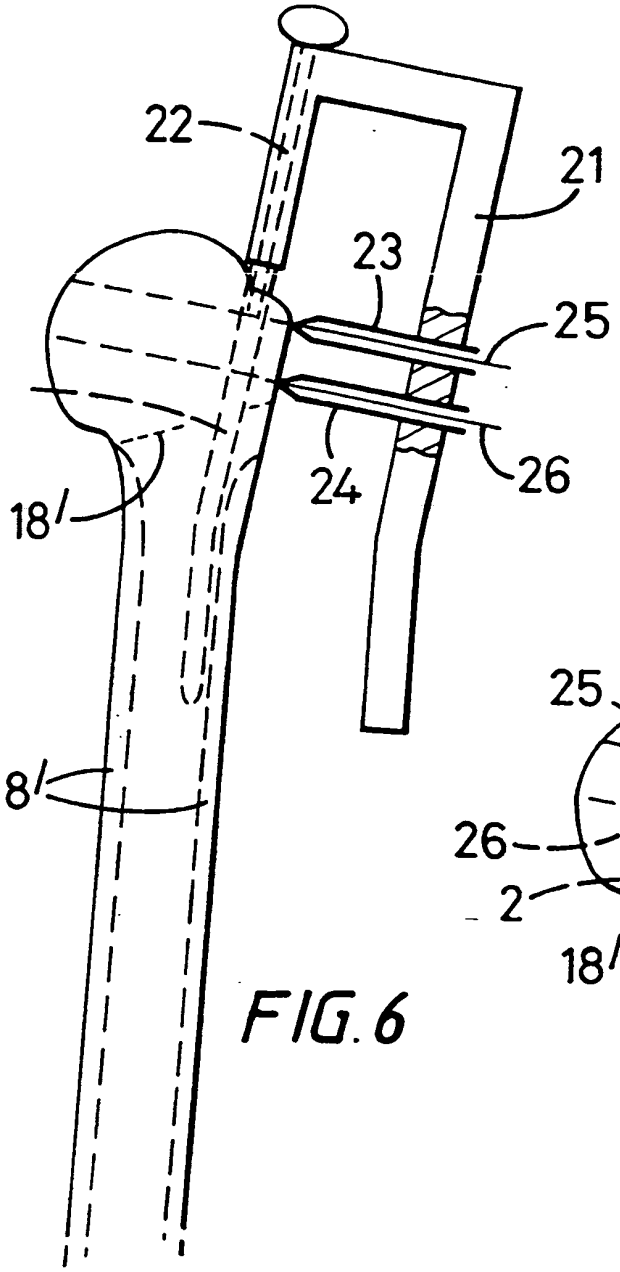


FIG. 6

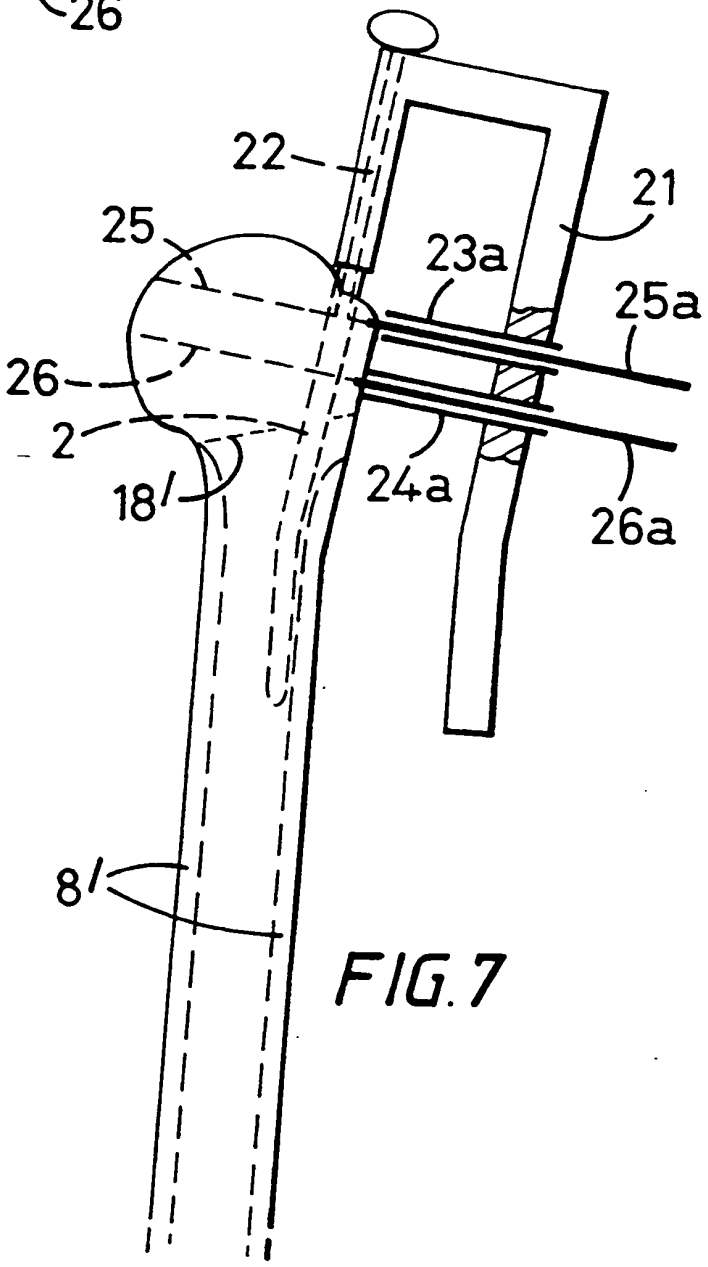


FIG. 7

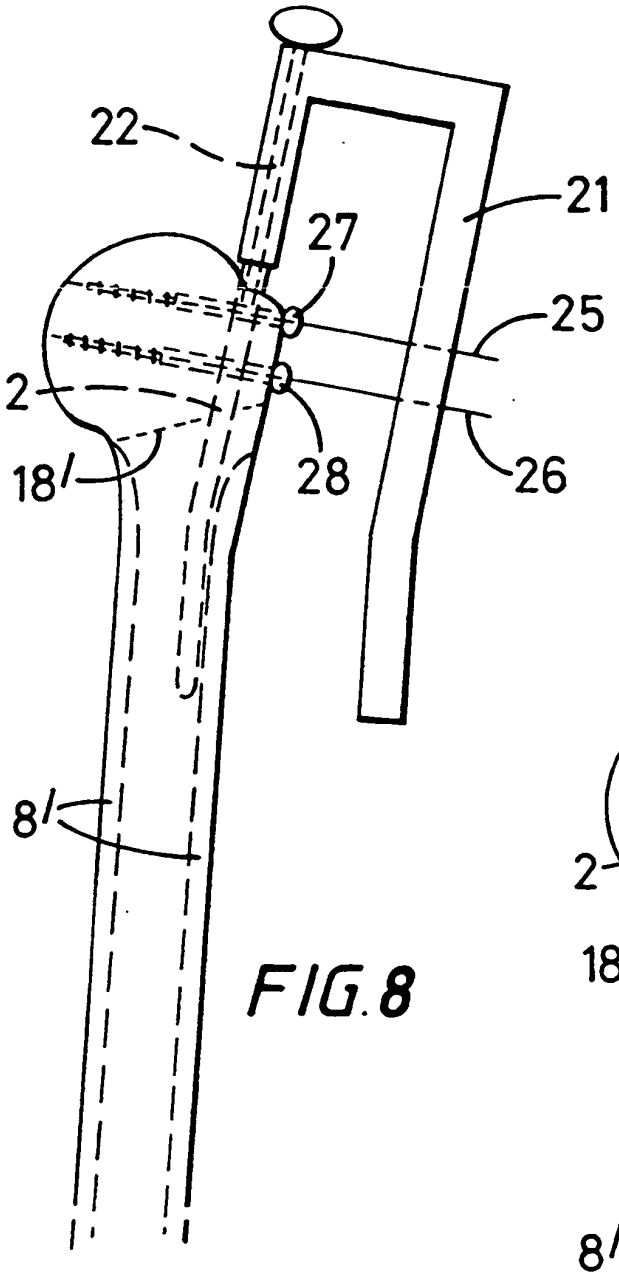


FIG.8

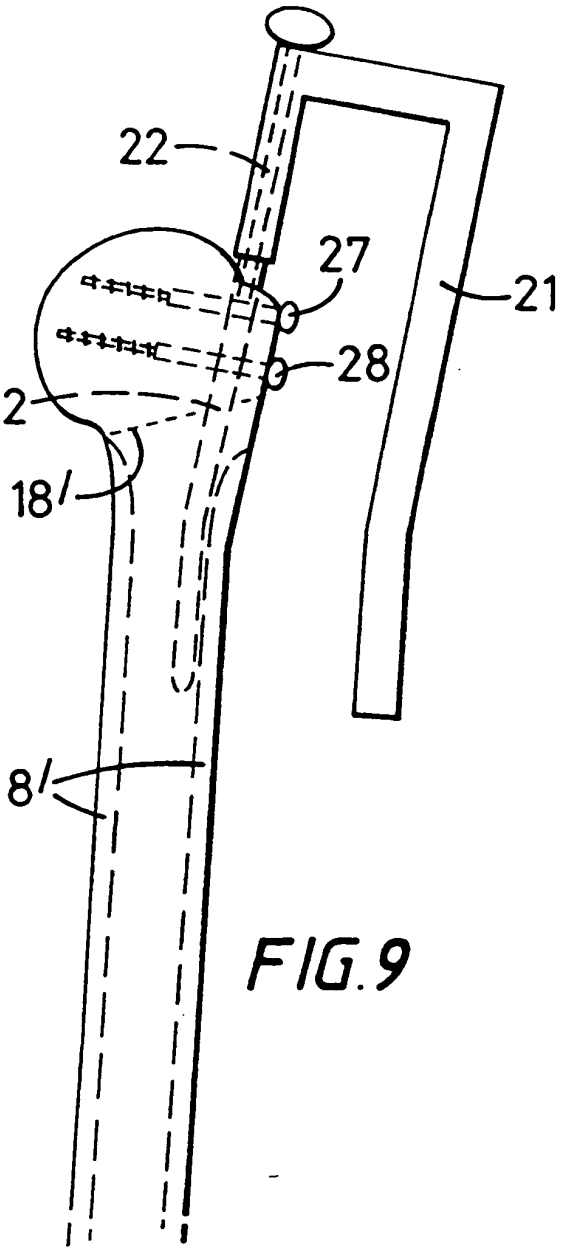


FIG.9

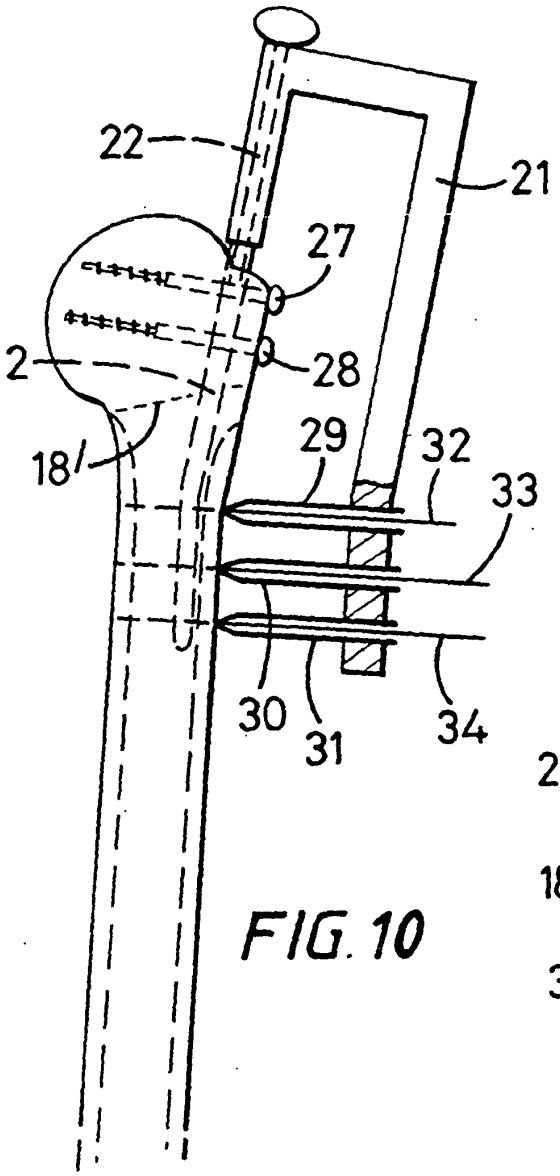


FIG. 10

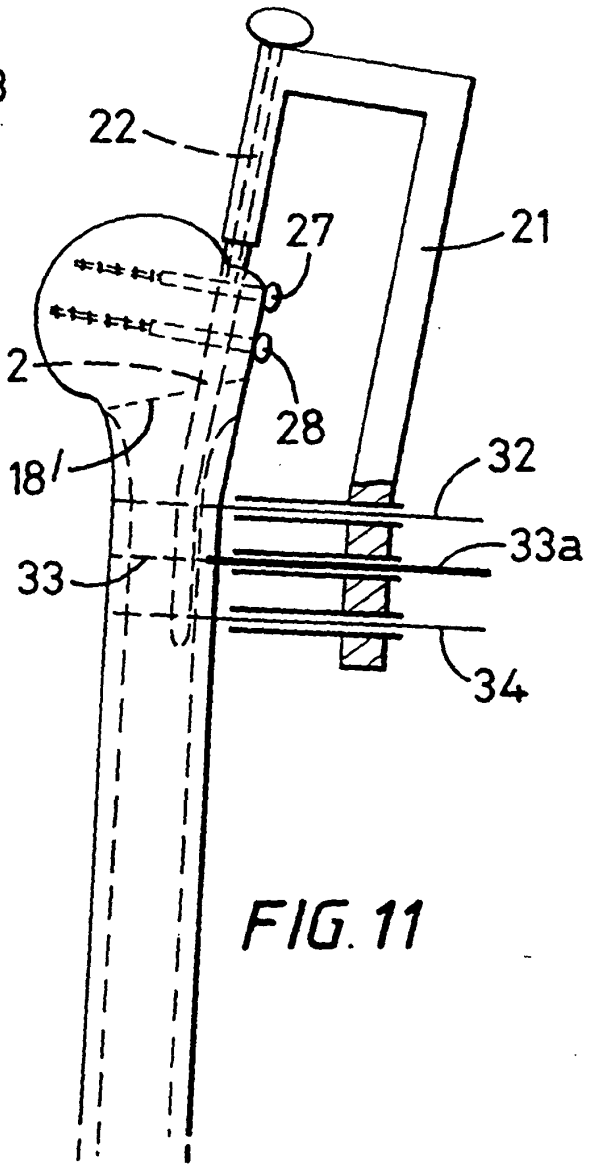


FIG. 11

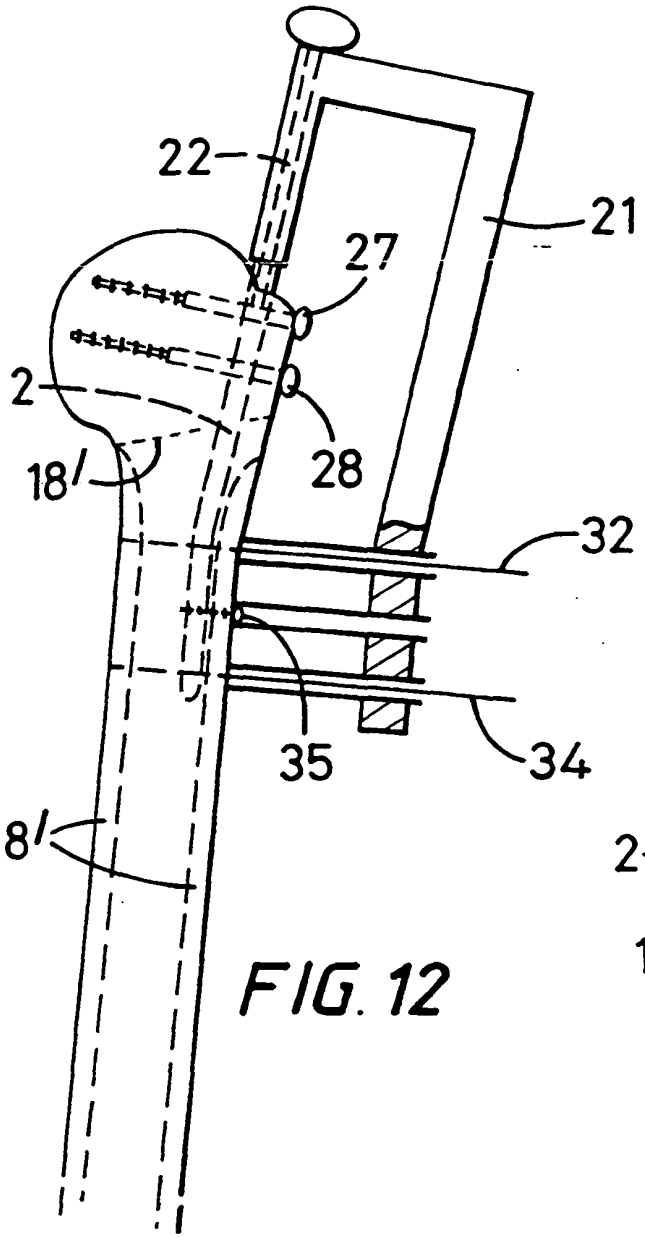


FIG. 12

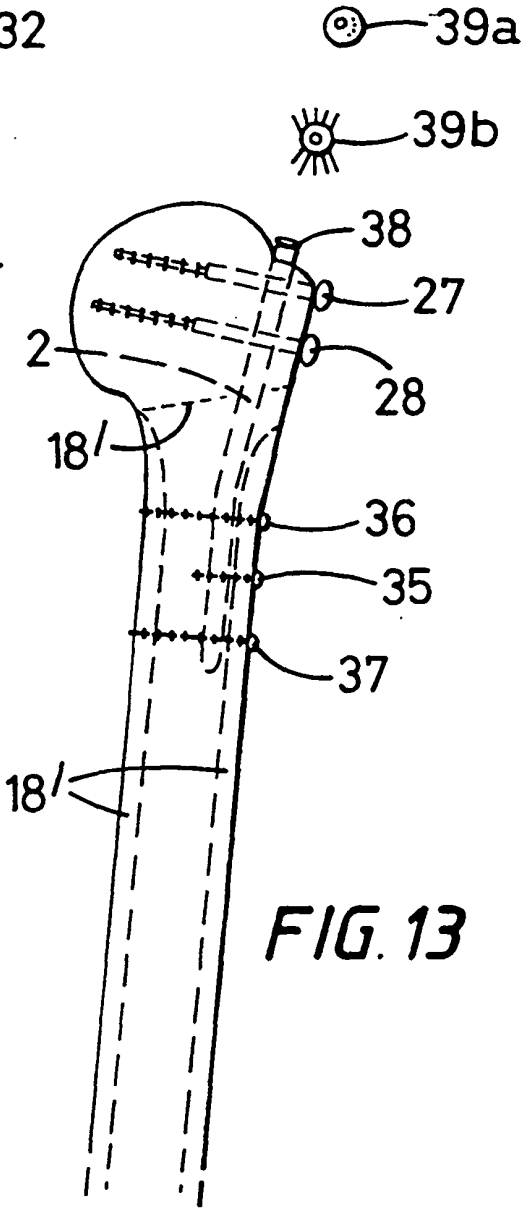


FIG. 13

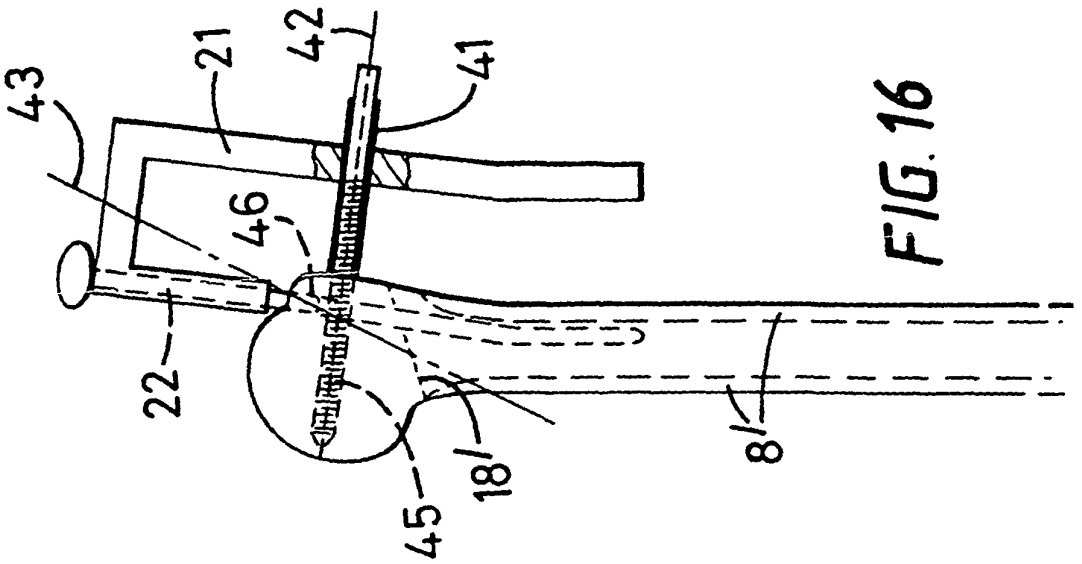


FIG. 16

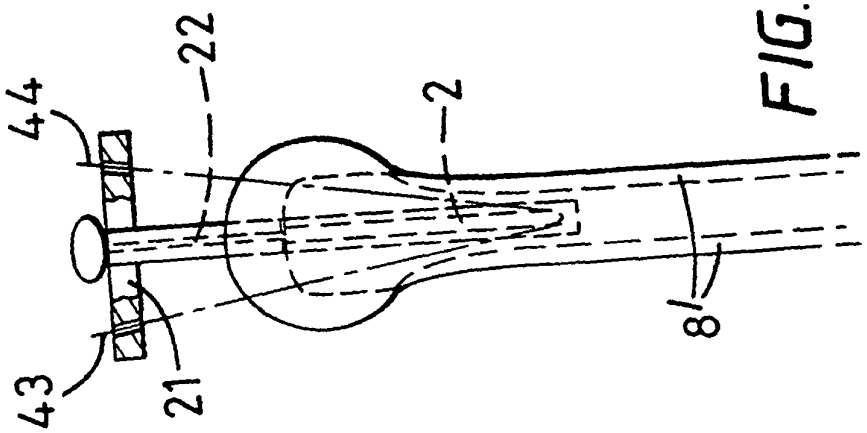


FIG. 15

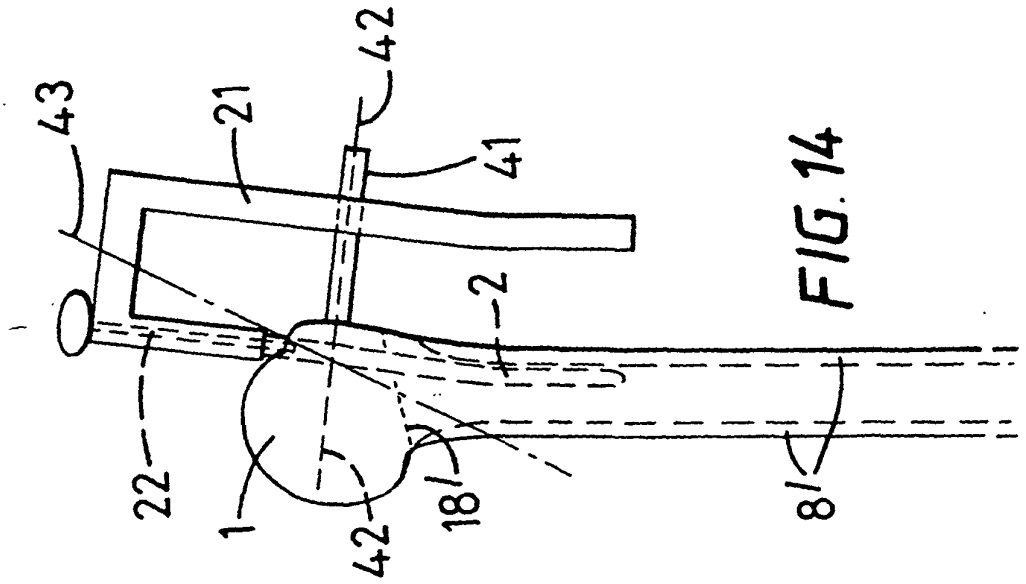


FIG. 14

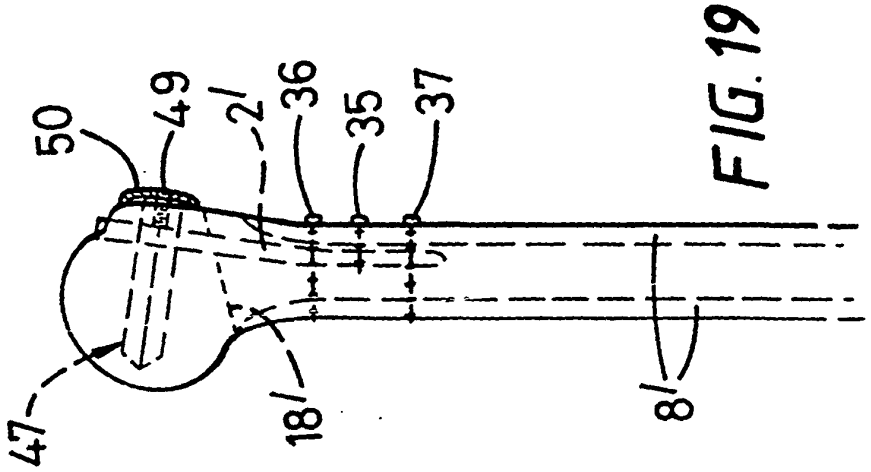


FIG. 19

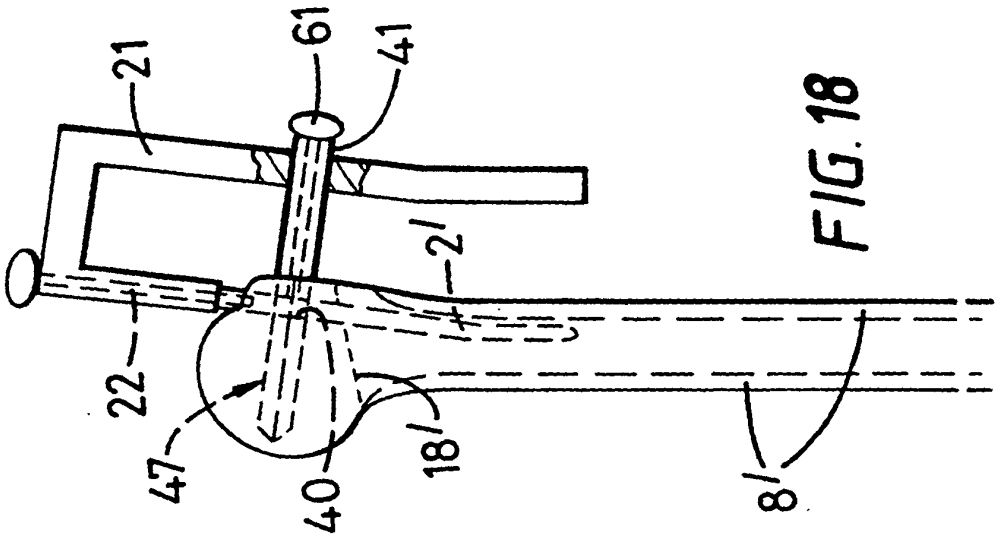


FIG. 18

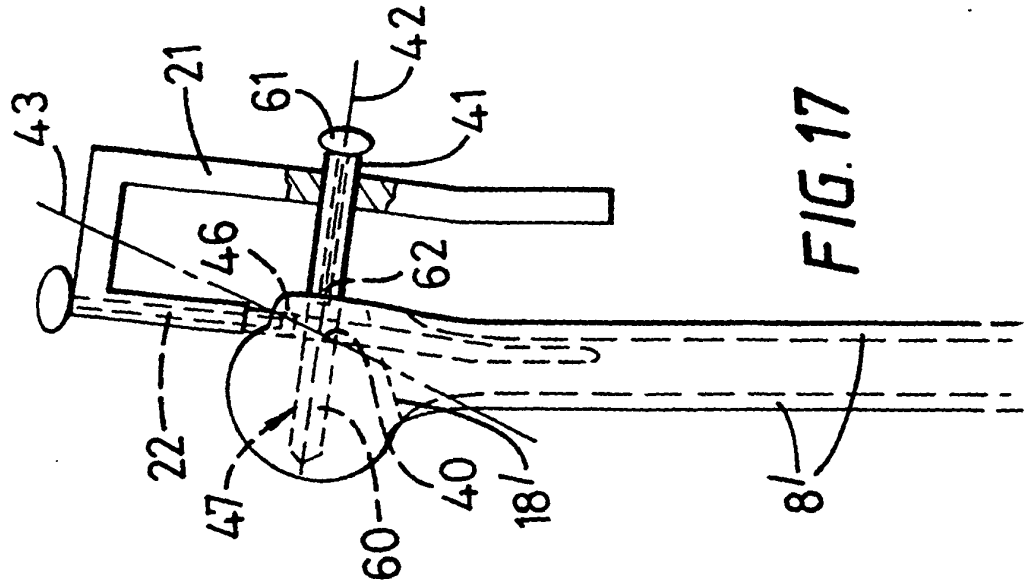


FIG. 17